NATURAL RESOURCES CONSERVATION SERVICE

VIRGINIA CONSERVATION PRACTICE STANDARD

POND SEALING OR LINING, FLEXIBLE MEMBRANE

(No.)

CODE 521A

DEFINITION

A manufactured hydraulic barrier consisting of a functionally continuous sheet of synthetic or partially synthetic, flexible material.

PURPOSE

To control seepage from water and waste impoundments for water conservation and environmental protection.

CONDITION WHERE PRACTICE APPLIES

On ponds and water storage structures that require treatment to control seepage rates within acceptable limits.

On waste storage and waste treatment facilities built in or of excavated earth, and which require treatment to prevent the migration of contaminants from the site.

CRITERIA

Water and waste impoundments to be lined shall be constructed to meet Virginia Conservation Practice Standards *Irrigation Pit (Code 552A), Regulating Reservoir (Code 552B), Irrigation Storage Reservoir (Code 436), Pond (Code 378), or Waste Treatment Lagoon (Code 359)* as appropriate.

All inlets, outlets, ramps, and other appurtenances may be installed before, during, or after the liner placement, but shall be done in a manner that does not damage or impair the proper operation of the liner.

SUBGRADE PREPARATION

Subgrade preparation shall conform to manufacturer recommendations. The foundation area for flexible membrane linings shall be smooth and free of projections that can damage the lining. Stumps and roots shall be removed. Rocks, hard clods, and other such material shall be removed, rolled so as to provide a smooth surface, or covered with a cushion of fine soil.

All plastic membranes shall have a cover of earth and gravel not less than 127 mm (5 in.) thick. Rubber membranes need not to be covered unless the areas will be traveled by livestock. In these areas, a minimum cover 228 mm (9 in.) shall be used on all types of flexible membranes. The soil material in the bottom 76 mm (3 in.) of the cover shall not be coarser than silty sand.

The quality of all membranes shall meet or exceed the attached specifications for materials for polyethylene and rubber (Tables 1 through 8). Polyvinyl chloride membranes shall meet the requirements of ASTM Specification D-3083 and Table 4.

Minimum nominal liner thickness shall be:

Soil material not coarser than —	Plastic Sheet	All others	
		Reinforced	Unreinforced
	mil		
Sands (SM, SP, SW)	8	20	30
Gravel (GC, GM, GP, GW)	12	30	30

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

The area to be lined shall be drained and allowed to dry until the surface is firm and can support the personnel and equipment that must travel over it during installation of the lining.

All bands and fills in the area to be lined must be sloped no steeper than 1 horizontal to 1 vertical for exposed linings and 2½ to 1 for buried linings.

If needed, an effective soil sterilant shall be applied to the subgrade at the rate recommended by the manufacturer.

An anchor trench shall be excavated completely around the area to be lined at the planned elevation of the top of the lining. The trench shall be 200 to 250 mm (8 to 10 in.) deep and about 300 mm (12 in.) wide.

MATERIAL

All flexible membranes shall be certified by the manufacturer to be suitable for the intended use.

Flexible membrane linings shall be suitably constructed of high-quality materials and shall be certified by the manufacturer to be suitable for this use. Pigmented polyvinyl or polyethylene plastics, rubber, and similar materials that are highly resistant to bacteriological deterioration shall be acceptable base materials.

Minimum Criteria for Membranes

Type	Limiting Parameter
HDPE	40 mil thickness
LLDPE	40 mil thickness
PVC	30 mil thickness
GCL	0.75 lb./sq. ft (bentonite)
EPDM	45 mil thickness

HDPE = High Density Polyethylene

LLDPE = Linear Low Density Polyethylene

PVC = Polyvinyl Chloride

GCL = Geosynthetic Clay Liner

EPDM = Synthetic Rubber

All lining material shall be free of damage or defect. Each package delivered to the job site shall bear the name of the material, the manufacturer's name or symbol, the quantity therein, and the thickness or weight of the material.

All materials are to meet the requirements indicated in Tables 1, 2, 3, 4, 5, 6, 7, and 8 as appropriate.

PLACEMENT

Membranes shall be loosely spread over the subgrade. Polyethylene film requires about 5 percent slack for satisfactory results.

All field splices shall be made according to the manufacturer's recommended technique, using materials furnished for this purpose. The joints shall be watertight and capable of maintaining their integrity throughout the expected life of the lining.

Approximately 200 mm (8 in.) of the top of the lining shall be placed in the anchor trench and anchored with compacted backfill.

LINER COVERING

Select soil materials shall be used as cover for liners where required for the proper performance, protection, and durability of the installation. For covered membranes, the material to be used as protective cover shall be free of large sharp rocks, sticks, and other objects that can puncture the lining. Maximum allowable particle size of soil cover material shall be 3/8-in (10 mm), unless the liner is cushioned by a needle punched, non-woven geotextile. The cover shall be placed to the specified depth without damage to the membrane. Cover materials shall be stable under all operational and exposure conditions.

Manufacturer recommendations shall be followed with regard to protection from weather and exposure.

VENTING

If venting is used, manufacturer recommendations shall be followed regarding vent type and spacing.

FENCING

All structures shall be fenced to protect the liner from damage and for the safety of humans, livestock, wildlife, and pets.

The area covered by a flexible membrane shall be fenced if livestock may be present to protect the membrane from puncture.

VEGETATION

The finished area shall be shaped and smoothed and all disturbed areas vegetated to protect against erosion. Mowing and maintenance activities shall be careful to avoid cutting or damaging the flexible membrane.

CONSIDERATIONS

Venting should be considered if gas build up under the liner is anticipated.

If high water tables could adversely affect the proper functioning of the facility, interceptor or relief type drainage systems should be considered to control uplift pressures.

Effects upon components of the water budget, especially effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge should be considered.

Consider the potential need for water management.

The following water quality concerns should be considered:

- Effects on the movement of silts, pathogens, and soluble materials carried by seepage toward the ground water
- Short-term and construction-related effects of this practice on the quality of the water resource
- Effects on wetlands or water-related wildlife habitats
- Effects on visual quality of downstream water resources
- Effects on the use and management of nutrients and pesticides and their effect on surface and ground water quality

PLANS AND SPECIFICATIONS

Plans and specifications for sealing water and waste impoundments with flexible membrane linings shall be in keeping with this standard and shall describe the site specific requirements for applying the practice to achieve its intended purpose.

DESIGN AND CHECK DATA

Record on design or in engineering field book.

Design Data

1. Statement concerning location and type of leaks or excessive permeability
2. Gradation and classification of soils to be sealed and water table location
3. Description of foundation preparation to be made
4. Type and thickness of membrane supported by structure and membrane design
5. Method of joint sealing and testing

Check Data

1. A statement of conformance to design with all exceptions noted
2. Certification by the manufacturer that the membrane is suitable for the intended use
3. Certification by contractor that the membrane was installed as designed by the manufacturer’s recommendations

OPERATION AND MAINTENANCE

A plan for operation and maintenance of the liner shall be prepared.

REFERENCE

1. Engineering Field Manual, Chapter 4, “Elementary Soil Engineering” and Chapter 11, “Ponds and Reservoirs”.

Table 1.— Requirements for polyethylene and ethylene co-polymer plastic film

Test description		Requirements		Test method
		Type I polyethylene	Type II co-polymer	
Tensile strength, each direction, minimum average	*lb/in.²*	1800	2000	ASTM-D-882, Method "A"
Ultimate elongation, each minimum average	*pct*	500	500	ASTM-D-882, Method "A"
Impact resistance, minimum average	*g/mil*	45	65	ASTM-D-1709, Method "B"
Water vapor permeability	*perm mil*	0.7	1.5	ASTM-E-96
Tear resistance, each direction, minimum	*g/mil*	80	80	ASTM-D-1922
Soil burial				
Tensile strength change, each direction, maximum	*pct*	5	5	ASTM-D-3083
Elongation loss, each direction, maximum	*pct*	20	20	
Luminous transmittance, maximum	*pct*	1.0	1.0	Nat Bureau of Stds Pub PS-17

Table 2.— Requirements for reinforced rubber sheeting

Test description		Requirements		Test method
		Up to 20 mil thick	20 mil thick and greater	
Breaking strength, minimum				ASTM-D-751
Warp direction	*lb/in.*	75	100	
Fill direction	*lb/in.*	75	100	
Ultimate elongation, maximum				ASTM-D-751
Warp direction	*pct*	30	30	
Ozone resistance, procedure "B" 50 pphm, 100 °F	*days*	7	7	ASTM-D-1149 and ASTM-D-518
Hydrostatic strength retained after ozone exposure, 7 days (Mullen)	*pct*	100	100	Federal Specification CCC 191b, Method 5512 and ASTM-D-518
Heat aging, 7 days at 212 °F				ASTM-D-573
Tensile strength retained	*pct*	90	90	
Elongation retained	*pct*	90	90	
Tear resistance, minimum, warp or fill direction	*lb*	8	8	ASTM-D-751 (tongue)
Hydrostatic burst (Mullen), minimum	*lb/in.²*	100	175	ASTM-D-751
Dimensional stability, 7 days at 212 °F Change in length or width	*pct*	±1.0	±1.0	([1])
Low-temperature flexibility (optional) No cracking or flaking		-40 °F	-40 °F	Federal Specification CCC 191b, Method 5874
Commercial field splice strength Shear force, minimum tensile	*pct*	75	75	Commercial field splice 1 -in.-wide strip, pulled in shear at 10 in./min, after 7 days cure at room temperature

[1]A 1-ft^2 sample, 10-inch bench marks in warp and fill direction , placed on aluminum or stainless plate in changing air over.

Table 3.— Requirements for unreinforced rubber sheeting

Test description		Requirements		Test method
		Type A	Type B	
Tensile strength, minimum	*lb/in.*^{2}	1,200	1,200	ASTM-D-412
Modulus at 300% elongation, minimum	*lb/in.*^{2}	600	600	ASTM-D-412
Ultimate elongation, minimum	*pct*	300	300	ASTM-D-412
Shore "A: hardness		60 ± 10	60 ± 10	ASTM-D-2240
Ozone resistance, procedure "A"				
No cracks, 50 pphm, 100 °F, 20% elongation	*days*	7	—	ASTM-D-518
No cracks, 100 pphm, 100 °F, 50% elongation	*days*	—	7	ASTM-D-518
Heat aging, 7 days at 212 °F				ASTM-D-573
Tensile strength retained	*pct*	75	75	
Elongation retained	*pct*	75	75	
Water vapor permeability at 80 °F, maximum	*perm mil*	0.002	0.05	ASTM-E-96 (procedure BW)
Tear resistance, minimum	*lb/in.*^{2}	150	150	ASTM-D-624 Die "B"
Dimensional stability, 7 days at 212 °F Change in length or width	*pct*	±0.5	±0.5	([1])
Low-temperature flexibility (optional) No cracking or flaking		-40 °F	-40 °F	Federal Specification CCC 191b, Method 5874
Commercial field splice strength Shear force, minimum tensile	*pct*	60	60	Commercial field splice 1 -in.-wide strip, pulled in shear at 10 in./min, after 7 days cure at room temperature

NOTE: Type "A" sheeting is recommended for general purposes outdoor use. Type "B" material is recommended for use if an extreme outdoor environment requires a highly weatherable lining.

Table 4.— Requirements of polyvinyl chloride plastic sheeting

Test description		Requirements	Test method
Tensile strength, each direction, minimum average	*lb/in.*^{2}	2,500	ASTM-D-882
Elongation at break, minimum	*pct*	250	ASTM-D-882, Method "A"
Volatile loss, maximum	*pct*	0.7	ASTM-D-882, Method "A"
Tear resistance, each direction, minimum	*g/mil*	160	ASTM-D-1922
Resistance to soil burial (percent change maximum in original value)			(120-day soil burial)
Breaking factor	*pct*	-5	
Elongation at break	*pct*	-20	
Modulus at 100% elongation	*pct*	±10	
Bonded seam strength, percent breaking factor	*pct*	80	ASTM-D-3083 Para. 9.3 (1-in. width)

Table 5.— Unreinforced chlorsulfonated polyethylene

Test description		Minimum requirements	Test method
Tensile strength, minimum	*lb/in.*^{2}	1,000	ASTM-D-412
Ultimate elongation, minimum	*pct*	250	ASTM-D-412
Ozone resistance, 50 pphm, 20% strain, 100 °F, 8,000 hr	*pct*	±0	ASTM-D-1149
Heat aging, 14 days at 212 °F			ASTM-D-412
Tensile strength, minimum	*lb/in.*^{2}	1,000	
Elongation at break	*pct*	150	
Tear resistance, minimum	*lb/in.*	250	ASTM-D-624 Die "B"
Commercial field splice strength Shear force, minimum tensile	*pct*	60	ASTM-D-882, Method "A", 7 days cure
Weight change after 7 days a 70 °F in water, maximum	*pct*	5	ASTM-D-471

Table 6.— Reinforced chlorsulfonated polyethylene

Test description		Minimum requirements 30 mils thick and greater	Test method
Breaking strength, minimum			ASTM-D-751
Rubber	*lb/in.*	100	
Fabric	*lb/in.*	75	
Ultimate elongation, maximum			ASTM-D-751
Rubber	*pct*	150	
Fabric	*pct*	120	
Ozone resistance, 50 pphm, 20% strain, 100 °F, 8,000 hr	*pct*	±0	ASTM-D-1149
Hydrostatic strength retained after ozone exposure, 7 days (Mullen)	*pct*	100	Federal Specification CCC 191b, Method 5512, ASTM-D-518
Heat aging, 14 days at 212 °F of original			
Tensile strength, minimum	*pct*	90	
Elongation at break	*pct*	90	
Tear resistance, pounds, minimum			ASTM-D-751
Warp or fill direction	*pct*	10	(Tongue)
Puncture resistance, pounds minimum		120	FTMS 101B, Method 2031
Commercial field splice strength Shear force, percent of minimum break	*pct*	75	ASTM-D-882, 7 days cure

Table 7.— Requirements for high density polyethylene (HDPE)

Test description	Requirements		
	80 mils	100 mils	Test method
Minimum tensile properties (each direction)			ASTM-D-638
1. Tensile strength yield (pounds/inch width)	120	150	
2. Tensile strength at break (pounds/inch width)	120	150	
3. Elongation at yield (percent)	10	10	
4. Elongation at break (percent)	500	500	
5. Modulus of elasticity (pounds/in.^{2})	80,000	80,000	
Tear resistance (pound, minimum)	40	50	ASTM-D-1004
Low temperature	- 40 °F	- 40 °F	ASTM-D-746
Dimensional stability (each direction, percent change, maximum	±10	±10	ASTM-D-1204 `212 °F, 15 min.
Resistance to soil burial[1] (percent change maximum in original value			ASTM-D-3083 (120-day soil burial)
1. Tensile strength yield	±10	±10	
2. Tensile strength at break	±10	±10	
3. Elongation at yield	±10	±10	
4. Elongation at break	±10	±10	
5. Modulus of elasticity	±10	±10	
Bonded seam strength[2] (factory seam, breaking factor, pounds/inch width)	108	135	ASTM-D-3083
Environmental stress crack (minimum, hours)	500	500	ASTM-D-1693

[1]Test value of "after exposure" sample is based on precut sample dimension; 120-day test is required for initial certification.

[2]Factory bonded seam strength is the responsibility of the fabricator.

Table 8.— Requirements for supported extruded polyurethane

Property	Test method	Supported finished material[2]			
		Type 1	Type 2	Type 3	Type 4
Thickness 1. Overall (mils, minimum)	ASTM-D-751	25	45	30	70
Minimum tensile properties	ASTM-D-751				
1. Breaking strength, (pounds, minimum)		50	70	110	100
fabric TD		70	120	120	140
fabric MD		90	160	130	220
composite TD		75	160	130	160
composite MD					
Tear strength (pounds minimum) composite	ASTM-D-751, Tongue	2.5	4.5	35	4.5
1. Initial	method, 8 X 8 sample	2.5	4.5	35	4.5
2. After heat aging					
		- 40 °F	- 40 °F	- 40 °F	- 40 °F
Low temperature composite	ASTM-D-2136, 1/8 in. mandrel, 4 hr, Pass	below - 60 °F			
Unsupported sheet, 100 mils					
Dimensional stability (each direction percentage change maximum)	ASTM-D_1204 212 °F, 1 hr	- 0.8	- 0.5	- 1.3	- 0.7
Resistance to soil burial[1]	ASTM-D-3083, 365 day soil burial, 30-mil sheet (as modified in Appendix A)				
a. Unsupported sheet	ASTM-D-882				
1. Breaking factor		+ 15			
2. Elongation at break		- 15			
3. Initial modulus	+ 30	TBD	TBD	TBD	TBD
b. Membrane fabric breaking factor	ASTM-D-751	greater than single layer			
Bonded seam strength (pounds, minimum)	ASTM-D-751 (as modified in Appendix A, 12 in./min)				
		80	210	250	280
Hydrostatic resistance (pounds per square inch, minimum)	ASTM-D-751 Method A Procedure I	NA			
Ozone resistance	ASTM-D-1149, (as modified in 7days, 100 pphm 104 °F, 1/8 in. bent loop)	NA			
Ply adhesion (each direction, pounds per square inch minimum)	ASTM-D-413, Machine Method Type A	0.4			
Volatile loss, percent, (Unsupported)	ASTM-D-1203 Method A 30-mil sheet				
		25	50	45	70
(Puncture resistance, pounds)	FTMS 101B (Method 2065)				

[1] Test value of "after exposure sample is based on precut dimension; 120-day test is required for initial certification.

[2] Supporting Fabrics:

Type 1: Nylon 6.6 2.0 oz/yd^2

Type 2: Polypropylene 3.1 oz/yd^2

Type 3: Composite of 2 layers 0.5 oz/yd^2 nylon 6.6 plus 5x5 1000d polyester scrim (4.1 oz/yd^2 total)

Type4: Polypropylene 4.4 oz/yd^2

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VIRGINIA CONSERVATION PRACTICE STANDARD

POND SEALING OR LINING, FLEXIBLE MEMBRANE

(No.)

CODE 521A

521A D1 Pond Sealing or Lining, Flexible Membrane: Install a liner designed to retain fresh water.

521A D2 Pond Sealing or Lining, Flexible Membrane: Install a liner designed to retain contaminated water and/or animal waste.

NRCS, VA, June 2001